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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

Hiroyuki FUKITA et al.

Serial No.: New Application

Group Art Unit:

Filed: March 21, 2002

Examiner:

For: METHOD FOR FINE PATTERN FORMATION

PRELIMINARY AMENDMENT

Commissioner for Patents  
Washington, D.C. 20231

Sir:

Prior to examination of the above-identified application,  
please enter the following changes below:

IN THE CLAIMS:

Amend claims 5 to 8, 19 to 24, 29 to 34, 36, and 38 and 39 as  
follows:

5. (Amended) The apparatus for fine pattern formation  
according to claim 1, wherein the protrusion length of the fine  
nozzles is in the range of 1 to 150  $\mu\text{m}$ .

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6. (Amended) The apparatus for fine pattern formation according to claim 1, wherein the fine holes in their openings on the surface side of the silicon substrate are in the form of tapered concaves which have been widened toward the surface side of the silicon substrate.

7. (Amended) The apparatus for fine pattern formation according to claim 1, wherein the fine holes in their openings on the surface side of the silicon substrate are in the form of multistaged concaves which have been widened toward the surface side of the silicon substrate.

8. (Amended) The apparatus for fine pattern formation according to claim 1, wherein fine holes are divided into two or more groups and ink passages are provided separately from each other or one another for respective fine hole groups.

19. (Amended) The apparatus for fine pattern formation according to claim 16, wherein the fine nozzles have an opening diameter in the range of 1 to 100  $\mu\text{m}$  and are provided at a pitch in the range of 4 to 1000  $\mu\text{m}$ .

21. (Amended) The apparatus for fine pattern formation according to claim 16, wherein the fine holes in their openings on the surface side of the silicon substrate are in the form of tapered concaves which have been widened toward the surface side of the silicon substrate.

23. (Amended) The apparatus for fine pattern formation according to claim 16, wherein the fine holes are divided into two or more groups and ink passages are provided separately from each other or one another for respective fine hole groups.









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face of the nozzle bases.

4. The apparatus for fine pattern formation according to claim 3, wherein the diameter of the openings in the fine nozzles is in the range of 1 to 100  $\mu\text{m}$  in a variation within  $\pm 1 \mu\text{m}$  and the fine nozzles are provided at a pitch in the range of 4 to 1000  $\mu\text{m}$ .

5. The apparatus for fine pattern formation according to any one of claims 1 to 4, <sup>claim 1</sup> wherein the protrusion length of the fine nozzles is in the range of 1 to 150  $\mu\text{m}$ .

6. The apparatus for fine pattern formation according to any one of claims 1 to 5, <sup>claim 1</sup> wherein the fine holes in their openings on the surface side of the silicon substrate are in the form of tapered concaves which have been widened toward the surface side of the silicon substrate.

7. The apparatus for fine pattern formation according to any one of claims 1 to 5, <sup>claim 1</sup> wherein the fine holes in their openings on the surface side of the silicon substrate are in the form of multistaged concaves which have been widened toward the surface side of the silicon substrate.

8. The apparatus for fine pattern formation according to any one of claims 1 to 7, <sup>claim 1</sup> wherein fine holes are divided into two or more groups and ink passages are provided separately from each other or one another for respective fine hole groups.

9. A process for producing a plurality of fine nozzles, formed of silicon oxide, protruded from one surface of a silicon substrate and in communication with fine holes which extend through the silicon substrate and have a silicon oxide layer on the wall surface thereof, said process comprising:

a first step of providing a silicon substrate having on its whole surface a silicon nitride layer and forming a mask pattern having a plurality of fine openings on the silicon nitride layer in its portion located on one surface of the silicon substrate;

a second step of forming through fine holes in the silicon substrate by deep etching using the mask pattern as a mask;



16. An apparatus for fine pattern formation comprising: a silicon substrate; a plurality of fine holes which extend through the silicon substrate from the surface of the silicon substrate to the back surface of the silicon substrate and have a silicon oxide layer on the wall surface thereof; fine nozzles which are protruded, integrally with the silicon oxide layer, on the back surface side of the silicon substrate from each opening of the fine holes; a reinforcing layer provided at least on the front end face and outer face of the fine nozzles; a support member provided on the surface side of the silicon substrate; an ink passage for supplying ink to the opening of each fine hole on the surface side of the silicon substrate; and an ink supplying device connected to the ink passage.

18. The apparatus for fine pattern formation according to claim 17, wherein the reinforcing layer is formed of any one of silicon oxide and phosphorus silicon glass.

20. The apparatus for fine pattern formation according to any one of claims 16 to 19, <sup>claim 16</sup> wherein the fine nozzles have a projection length in the range of 10 to 400  $\mu\text{m}$ .

21. The apparatus for fine pattern formation according to any one of claims 16 to 20, <sup>Claim 16</sup> wherein the fine holes in their

openings on the surface side of the silicon substrate are in the form of tapered concaves which have been widened toward the surface side of the silicon substrate.

22. The apparatus for fine pattern formation according to any one of claims 16 to 20, <sup>claim 16</sup> wherein the fine holes in their openings on the surface side of the silicon substrate are in the form of multistaged concaves which have been widened toward the surface side of the silicon substrate.

23. The apparatus for fine pattern formation according to any one of claims 16 to 22, <sup>claim 16</sup> wherein the fine holes are divided into two or more groups and ink passages are provided separately from each other or one another for respective fine hole groups.

24. The apparatus for fine pattern formation according to ~~any one of claims 16 to 23~~ <sup>claim 16</sup> wherein a water-repellent layer is provided at least on the reinforcing layer, provided on the outer face of the fine nozzles, and on the back surface side of the silicon substrate.

25. The apparatus for fine pattern formation according to claim 24, wherein the water-repellent layer is formed of fluorocarbon.

26. An apparatus for fine pattern formation, comprising: a silicon substrate; a plurality of fine holes provided so as to extend through the silicon substrate from the surface of the silicon substrate to the back surface of the silicon substrate; a main electrode provided on the surface side of the silicon substrate; a counter electrode provided on the back surface side of the silicon substrate while leaving a predetermined space between the main electrode and the counter electrode; a support member provided on the surface side of the silicon substrate; an ink passage for supplying ink to openings in the fine holes on the surface side of the silicon substrate; and an ink supplying device connected to the ink passage.

27. The apparatus for fine pattern formation according to claim 26, wherein nozzles are protruded on the back surface side of the silicon substrate from the openings of the fine

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holes.

28. The apparatus for fine pattern formation according to claim 27, wherein the wall surface of the fine holes has a silicon oxide layer and the nozzles are formed of silicon oxide.

29. The apparatus for fine pattern formation according to <sup>claim 26</sup> [any one of claims 26 to 28], wherein the counter electrode is in a drum or flat plate form.

30. The apparatus for fine pattern formation according to <sup>claim 26</sup> [any one of claims 26 to 29], wherein the fine holes have an opening diameter in the range of 1 to 100  $\mu\text{m}$  and are provided at a pitch in the range of 2 to 1000  $\mu\text{m}$ .

31. The apparatus for fine pattern formation according to <sup>claim 27</sup> [any one of claims 27 to 30], wherein the nozzles have a protrusion length in the range of 10 to 400  $\mu\text{m}$ .

32. The apparatus for fine pattern formation according to <sup>claim 26</sup> [any one of claims 26 to 31], wherein the fine holes in their openings on the surface side of the silicon substrate are in the form of tapered concaves which have been widened toward the surface side of the silicon substrate.

33. The apparatus for fine pattern formation according to <sup>claim 26</sup> [any one of claims 26 to 31], wherein the fine holes in their openings on the surface side of the silicon substrate are in the form of multistaged concaves which have been widened toward the surface side of the silicon substrate.

34. The apparatus for fine pattern formation according to <sup>claim 26</sup> [any one of claims 26 to 33], wherein fine holes are divided into two or more groups and ink passages are provided separately from each other or one another for respective fine hole groups.

35. The apparatus for fine pattern formation according to claim 34, wherein main electrodes are separately provided for respective fine hole groups.

36. A method for fine pattern formation, comprising the step of: while relatively scanning the apparatus for fine pattern formation according to <sup>claim 26</sup> [any one of claims 26 to 35] and a pattern object in a predetermined direction,

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continuously or intermittently ejecting ink supplied at low pressure from the ink passage onto the pattern object through the fine holes in such a state that a voltage is applied to the main electrode in the apparatus for fine pattern formation, whereby a stripe pattern or a dot pattern is formed.

37. The method for fine pattern formation according to claim 36, wherein stripes constituting the pattern are formed by supplying ink through a plurality of fine holes arranged on an identical line along the scanning direction.

38. A method for fine pattern formation, comprising the steps of: disposing the apparatus for fine pattern formation according to <sup>claim 26</sup> any one of claims 26 to 35 at a predetermined position of a pattern object; and ejecting a given amount of ink supplied at low pressure from the ink passage onto the pattern object through the fine holes in such a state that a voltage is applied to the main electrode of the apparatus for fine pattern formation, whereby a pattern is formed.

39. A method for fine pattern formation according to <sup>claim 36</sup> any one of claims 36 to 38, wherein the voltage applied to the main electrode is regulated to control ink ejection width and the amount of ink ejected.